Determination of Total Lung Capacity (TLC) without Body Plethysmography

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Introduction

• Among the most basic measures of respiratory function is the total lung capacity (TLC).
• Determination of TLC requires body plethysmography, gas dilution or washout, or thoracic imaging, each of which is more complex than spirometry and none of which is suited to routine office practice, population and occupational screening, or community medicine.
• To address these issues, we describe here a novel approach and table-top device to determine TLC called the MiniBox.

MiniBox

• The MiniBox is a table-top unit that includes a conventional spirometer and a flow-interruption device.
• Brief flow interruptions (~70 msec) are triggered near mid-inspiration on each tidal breath, resulting in measurable flow transients between the subject’s lungs and the rigid container.
• Measured data from both the conventional spirometer and the flow-interrupter is used to compute an unbiased estimate of TLC based on a PulmOne model (patent pending) developed within the Clinical Study.

Clinical Study Design

Adult subjects were measured with the MiniBox (spirometer and flow-interrupter) (TLCmb) and with a conventional body plethysmograph (TLCpleth).

The study comprised three parts:

1) Initial development of a statistical model for TLCmb
2) Validation of TLCmb equation with N-fold cross-validation
3) Prospective validation of TLCmb equation

Results

N-Fold Cross-Validation: The mean prediction error using 10-fold cross-validation is 0.437 L with the mean prediction standard error (SE) of 0.00171 L. The 5-fold cross-validation also produced similar mean prediction errors.

Day-to-Day Repeatability: The coefficient of variation (CV) for repeated measurements on different days was 3.3% for TLCpleth and 1.6% for TLCmb.

Discussion

• By applying a PulmOne model (patent pending) to spirometry and flow-interruption data, we identified key features of these data that allow estimation of TLC with clinical accuracy across the entire population studied and across specific patient subgroups.
• These results establish the validity and potential utility of the MiniBox for rapid, accurate, and repeatable determination of TLC in a heterogeneous patient population.
• Additional studies will explicitly assess the accuracy of TLCmb in children and in adults with unusual conditions that were not sufficiently represented in the study population (neuromuscular weakness, combined obstruction and restriction, etc.).

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